Still another embodiment of a spacer of the present invention can include a unitary metallic spacer having an upper cylindrical outer surface that can support a coat of sealant material and a lower serrated cylindrical surface adjacent a flange that can be adhered to a panel surface. Between the upper cylindrical outer surface and the lower serrated cylindrical surface, the body of the spacer has an outer concave annular groove. The upper cylindrical outer surface has a hollow interior with an inner annular groove to facilitate a deformation of the upper entrance rim to a flush position with the panel surface during mounting.

The spacers can be installed in a sandwich structure panel by a method of initially boring a hole in the panel of a dimension slightly larger than the outer diameter of the spacer, for example with a diamond edge cutting tool. The spacer is then inserted into the hole and has a length that is greater than the thickness of the panel. The lower flange of the spacer can be coated with an adhesive to permit a direct bonding between the lower flange and the lower surface of the panel. Therefore, the entrance rim of the spacer will extend above an upper surface of the panel by a predetermined distance. A setting tool member having an appropriately configured contact surface can be inserted into the spacer so that the curved contact surface of the setting tool will compress the entrance rim downward and outward to provide a slight outward convex bulge that will assist in locking the spacer into the panel, while permitting the upper surface of the entrance rim to become flush with the upper surface of the panel as it is sealed.

Alternatively, a spacer with a lower serrated surface of a slightly greater diameter than the remainder of the upper body can provide a low friction

engagement with the hole to help maintain the alignment of the spacer during the subsequent mounting with a setting tool.

An alternate setting tool can have an indented flat annular groove with a supporting annular cylindrical post to receive the entrance rim and apply a downward force to create an outward convex bulge beneath the panel surface as pre-designed by the configuration of the inner annular groove.

The setting tool for applying the force to the upper rim of the spacer can be bifurcated into two separate components to permit a replacement setting head to be inserted on a hand tool applicator with the replacement setting head providing the direct contact force to the rim.

The sealing compound is thus applied automatically to the hole in the sandwich panel with the spacer being the carrier of the sealing compound. This facilitates an automatic installation of spacers in the aerospace industry.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages, may best be understood by reference to the following description, taken in connection with the accompanying drawings.

Figure 1 is a partial cross-sectional view of a first embodiment of the present invention;

Figure 2 is a schematic illustration of preparing a sandwich panel for the spacer of the present invention;

Figure 3 is a schematic view of a partial cross-sectional spacer of the first embodiment of the invention mounted within a sandwich panel;

Figure 4 is a partial cross-sectional view disclosing the application of a mounting force on the rim of a spacer mounted in the sandwich panel;

Figure 5 is a cross-sectional view disclosing a spacer flush-mounted in a sandwich panel;

Figure 6 is a perspective partial cross-sectional view disclosing a spacer mounted in a sandwich panel;

Figure 7 is an elevated view of the spacer with sealing compound of the present invention;

Figure 8 is a partial cross-sectional view of an alternative embodiment of the spacer of the present invention;

Figure 9 is a partial cross-sectional view of another embodiment of the spacer of the present invention;

Figure 10 is a partial cross-sectional view of a floor panel and spacer combination fastened to a bulkhead of an aircraft;

Figure 11 is a prospective view of the spacer of Figure 8;

Figure 12 is a partial cross-sectional view of still another embodiment of the spacer of the present invention;

Figure 13 is a partial cross-sectional view disclosing an alternative application of a mounting force on the rim of a spacer positioned within a sandwich panel; and

Figure 14 is a perspective partial cross-sectional view disclosing the spacer of Figure 12 mounted in a sandwich panel.